Climate Change Impact Study with CMIP5 and Comparison with CMIP3

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ABSTRACT

One of significant uncertainties in climate change impact study is the selection of climate model projection including the choosing of greenhouse gas emission scenarios. With the new generation of climate model projection, CMIP5, coming into use, CCTAG selected 11 climate models and two RCPs (rcp4.5 and rcp8.5) for California. Previous DWR climate change study was based on 6 CMIP3 climate models and two emission scenarios (SRES A2 and B1) which were selected by CAT. It is an unanswered question that how the selection of these climate model projections and emission scenarios affect the assessment of climate change impact on future water supply of California CVP/SWP project. This work will run the water planning model CalSim in DWR with 44 CMIP5 and 12 CMIP3 climate model projections to investigate the sensitivity of climate model impact study on future water supply in the CVP/SWP region to the section of climate model projection.

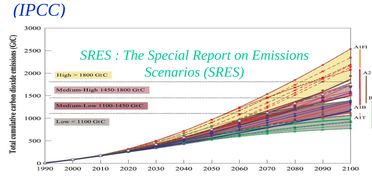
It was found that in 2060 CMIP5 projects the wetting trend in Northern California while CMIP3 projects the drying trend in the entire California on the average. And CMIP5 projects about half-degree more warming than CMIP3. As a result, Sacramento River rim inflow increases by 8% for CMIP5 and reduces by 3% for CMIP3. In spite of this difference in rim inflow, north of Delta carryover storage will be reduced both under CMIP5 (13%) and under CMIP3 (20%) in 2060. And south Delta export will be reduced both for CMIP5 (8%) and for CMIP3 (15%).

Previous CC Impact Study with CMIP3 in DWR

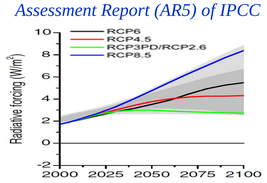
- 2006: "Progress on Incorporating Climate Change into Management of California's Water Resources"
- 2009: "Using future climate projections to support water resources decision making in California "
- BDCP: "APPENDIX 5A.2 CLIMATE CHANGE APPROACH AND IMPLICATIONS FOR AQUATIC SPECIES"

CMIP3 vs. CMIP5

CMPI3 *(23 AOGCMs) :Coupled Model Intercomparison Project Stage 3, used for the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC)*



CMIP5 *(31 AOGCMs or ESMs): : Coupled Model Intercomparison Project Stage 5, used for the Fifth Assessment Report (AR5) of IPCC*



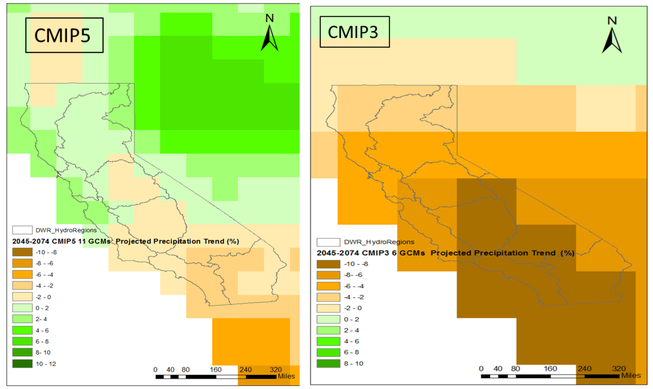
Four RCPs (Representative Concentration Pathways): RCP 2.6, RCP4.5, RCP6.0 , and RCP 8.5

Selection of GCM Projections from CMIP3 and CMIP5

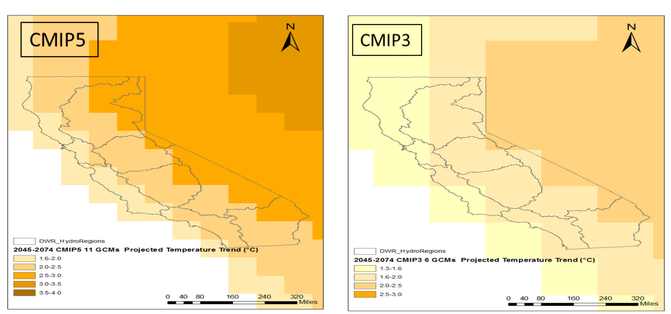
Selection of CMIP5 GCM Projections					
Model	**Institution**	**Ensemble Run**		**RCP**	**Subtotal**
ACCESS 1.0	Centre for Australian Weather and Climate Research	1	rcp45	rcp85	2
CMCC-CMS	Euro-Mediterranean Center of Italy	1	rcp45	rcp85	2
CESM1-BGC	NCAR (USA)	1	rcp45	rcp85	2
CCSM4	NCAR (USA)	5	rcp45	rcp85	10
CNRM-CM5	National Centre for Meteorological Research of France	1	rcp45	rcp85	2
MIROC5	Center for Climate System Research of Japan	1	rcp45	rcp85	2
GFDL-CM3	GFDL (USA)	1	rcp45	rcp85	2
GFDL-ESM2M	GFDL (USA)	1	rcp45	rcp85	2
HadGEM2-ES	Hadley Centre of UK	4	rcp45	rcp85	8
HadGEM2-CC	Hadley Centre of UK	1	rcp45	rcp85	2
CANESM2	Canadian Centre for Climate Modelling and Analysis	5	rcp45	rcp85	10
				Total Projections	44

Selection of CMIP3 GCM Projections					
Model	**Institution**	**Ensemble Run**		**SRES**	**Subtotal**
MPI-ECHAM5	Max Planck Institute for Meteorology of German	1	A2	B1	2
GFDL-CM2.1	GFDL (USA)	1	A2	B1	2
NCAR PCM1	NCAR (USA)	1	A2	B1	2
NCAR CCSM3	NCAR (USA)	1	A2	B1	2
CNRM-CM3	National Centre for Meteorological Research of France	1	A2	B1	2
MIROC3.2-MED	Center for Climate System Research of Japan	1	A2	B1	2
				Total Projections	12

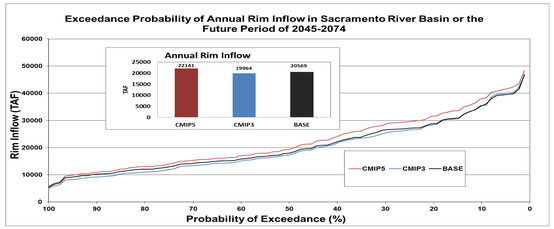
Precipitation Trend Projected By Selected CMIP3 and CMIP5 Projections

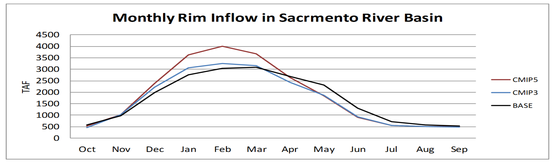


Temperature Trend Projected By Selected CMIP3 and CMIP5 Projections



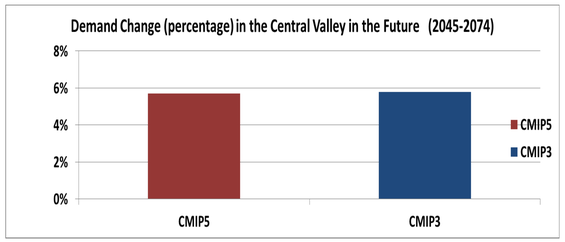
Climate Change Rim Inflow: Annul Volume and Monthly Flow in 2045-2074





Climate Change Valley Floor Water Demand

- *Perturb Temperature in Valley Floor Hydrology Model*
- *Perturb Precipitation*
- *Perturb Evaportranspiration Rate*



New Water Planning Model for Climate Change Impact Study : CalSim 3.0

- *Increased spatial resolution of rim and expanded representation of water control facilities in rim watersheds*
- *Consistent and transparent representation of Central Valley floor hydrology facilitates the representation of climate change effects on agricultural, urban, and managed wetland water demands.*
- *Coupled representation of surface water and groundwater allows impacts of climate change on groundwater to be evaluated and potentially supports long-term management of groundwater resources*

Variable Sea Level Rise in 2045-2074

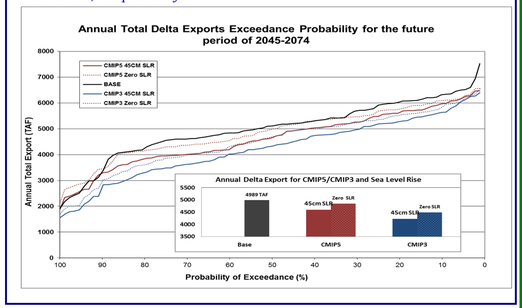
- *For each climate model projection CalSim 3.0 runs twice, with zero and 1.5ft sea level rises, respectively, total 112 runs*
- *The Martin Vermeera and Stefan Rahmstorf (2009) approach is used for the estimate of future sea level rise for each climate projection. Then interpolate using CalSim 3.0 run result of zero and 1.5ft sea level rise.*

Biological Opinion Adopted in each CalSim 3.0 Run

- *A biological opinion (BO) on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the Central Valley Project and State Water Project*
- *Regulate Old and Middle River (OMR) flow to protect Delta Smelt*

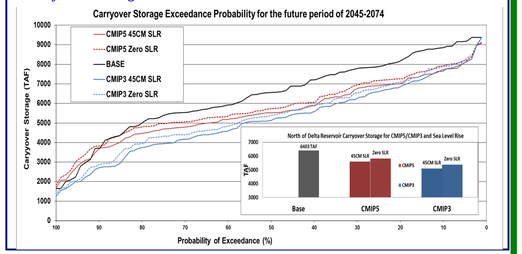
Climate Change Impact on SWP/CVP: South of Delta Export

- *Annual Delta export all reduced for CMIP5 and CMIP3 by -3% and -10% , respectively for no sea level rise scenario.*
- *After adding 45cm (1.5ft) sea level rise, the export reduced by -8% and -15%, respectively.*



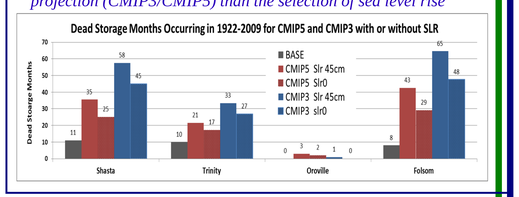
Climate Change Impact: North of Delta Carryover Storage

- *The carryover storage is reduced by 14% for CMIP5 and reduced by 23% for CMIP3 under 1.5ft Sea Level Rise in 2060*
- *The sea level rise of 1.5ft only contributes 4-5% reduction in carryover storage.*



Climate Change Impact: Dead Storage

- *CMIP3 triggers more dead storages than CMIP5*
- *Sea level rise causes more dead storages*
- *Dead storage is more sensitive to the selection of climate model projection (CMIP3/CMIP5) than the selection of sea level rise*



Summary and Conclusion

- *The CC impact uncertainty caused by the selection of climate model projection (CMIP3 vs CMIP5) is about 7% in terms of Delta export and about 9% in terms of north of Delta carryover storage.*
- *The CC impact uncertainty caused by the selection of sea level rise (Zero vs 1.5ft SLR) is about 5% in terms of Delta export and about 4-5% in terms of North of Delta carryover storage.*